

The Scientific Review, AND SCIENTIFIC AND LITERARY REVIEW,

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IMPROVED WINDMILL.—The advantages claimed for this windmill are that it may be readily adjusted while running, it is acted upon by wind blowing from any direction, and as the vanes are curved so that their inner edges are nearly at right angles with the course of the wind, the action of the wind is positive, and the greatest amount of the power of the wind is realised; also that the wind has free and unobstructed discharge from the wheels.

Reviews.

THE TELEGRAPH OFFICE.

"The Telegraph Office, or Simple Instruction in the Mechanism of Instruments and Batteries, for Country Postmasters and others employed in Small Offices, where Single Needle and Alphabetical Instruments only are used." Compiled by Officers of the Royal Engineers employed in the Postal Telegraph Service. Cassell, Petter, and Galpin, London, Paris, and New York.

This is an admirable little work conveying just as much elementary knowledge as is absolutely necessary for country postmasters and others who are not likely to have the knowledge of the skilled users of the Electric Telegraph, the object of the work being to enable persons unacquainted with the principles of electricity, who may not be provided with galvanometers or other appliances for the detection of faults, to maintain their apparatus to a great extent in working order, and to gain some slight insight into its construction. The description of the Wheatstone alphabetical instrument which follows, is however necessarily more exhaustive and technical.

The work briefly refers to the coils, and as to their removal to the inducing magnets; the earth wire; the tappers; the circuit; line connections; battery connection; sending reversed signals; inability to send or disconnection, and gives plain directions as to the steps to be then taken.

Leclanché and Daniel's Batteries, as far as directions to make up new, &c., are concerned, are dealt with in a plain practical way, and Wheatstones, A B C instruments are succinctly yet comprehensively described. Illustrations accompany the text, so that this little work is really a book of elementary yet practical instruction as to the Electric Telegraph as far as the instruments for telegraphing are concerned.

As a hint for future editions we would remark that as regards the illustrations and the references to them that improvement may still be effected.

DARWIN ON FORMS OF FLOWERS.

"The Different Forms of Flowers on Plants of the same Species." By CHARLES DARWIN, M.A., F.R.S. With Illustrations. London: John Murray, Albemarle Street. 1877.

As we have no taste or aptitude for painting the lily or adorning the rose, we shall endeavour to present our readers with evidence taken from the book itself; that this work is an interesting, readable account of persevering scientific researches made or supervised by Mr. Darwin on a subject of interest to almost everybody;—for there are very few persons who take no interest whatever in flowers.

Mr. Darwin, in his Introduction, gives a good idea of the general scope of the work as follows:—"The subject of the present volume, namely the differently formed flowers normally produced by certain kinds of plants, either on the same stock or on distinct stocks, ought to have been treated by a professed botanist, to which distinction I can lay no claim. As far as the sexual relations of flowers are concerned, Linnaeus long ago divided them into hermaphrodite, monocious, dioecious, and polygamous species. This fundamental distinction, with the aid of several subdivisions in each of the four classes, will serve my purpose; but the classification is artificial, and the groups often pass into one another.

The hermaphrodite class contains two interesting sub-groups, namely, heterostyled and cleistogamic plants; but there are several other less important subdivisions, presently to be given, in which flowers differing in various ways from one another are produced by the same species.

Some plants were described by me several years ago, in a series of papers read before the Linnean Society, the individuals of which exist under two or three forms, differing in the length of their pistils and stamens and in other respects. They were called by me dimorphic and trimorphic, but have since been better named by Hildebrand, heterostyled. As I have many still unpublished observations with respect to these plants, it has seemed to me advisable to republish my former papers in a connected and corrected form, together with the new matter. It will be shown that these heterostyled plants are adapted for reciprocal fertilisation; so that the two or three forms, though all are hermaphrodites, are related to one another almost like the males and females of ordinary unisexual animals. I will also give a full abstract of such observations as have been published since the appearance of my papers; but only those cases will be noticed, with respect to which the evidence seems fairly satisfactory. Some plants have been supposed to be heterostyled merely from their pistils and stamens varying greatly in length, and I have been myself more than once deceived. With some species the pistil continues growing for a long time, so that if old and young flowers are compared they might be thought to be heterostyled. Again, a species tending to become dioecious, with the stamens reduced in some individuals and with the pistils in others, often presents a deceptive appearance. Unless it be proved that one form is fully fertile only when it is fertilised with pollen from another form, we have not complete evidence that the species is heterostyled. But when the pistils and stamens differ in length in two or three sets of individuals, and this is accompanied by a difference in the size of the pollen-grains or in the state of the stigma, we may infer with much safety that the species is heterostyled. I have, however, occasionally trusted to a difference between the two forms in the length of the pistil alone, or in the length of the stigma together with its more or less papillose condition; and in one instance differences of this kind have been proved by trials made on the fertility of the two forms, to be sufficient evidence.

The second sub-group above referred to consists of hermaphrodite plants, which bear two kinds—the one perfect and fully expanded, the other minute, completely closed, with the petals rudimentary, often with some of the anthers aborted, and the remaining ones together with the stigmas much reduced in size; yet these flowers are perfectly fertile. They have been called by Dr. Kuhn cleistogamic, and they will be described in the last chapter of this volume. They are manifestly adapted for self-fertilisation, which is effected at the cost of a wonderfully small expenditure of pollen; whilst the perfect flowers produced by the same plant are capable of cross-fertilisation. Certain aquatic species, when they flower beneath the water, keep their corollas closed, apparently to protect their pollen; they might therefore be called cleistogamic, but for reasons assigned in the proper place are not included in the present sub-group. Several cleistogamic species, as we shall hereafter see, bury their ovaries or young capsules in the ground; but some few other plants behave in the same manner; and, as they do not bury all their flowers, they might have formed a small separate subdivision.

Another interesting subdivision consists of certain plants, discovered by H. Müller, some individuals of which bear conspicuous flowers adapted for cross-fertilisation by the aid of insects, and others much smaller and less conspicuous flowers, which have often been slightly modified so as to ensure self-fertilisation. *Lysimachia vulgaris*, *Euphrasia officinalis*, *Rhinanthus crista-galli*, and *Viola tricolor* come under this head. The smaller and less conspicuous flowers are not closed,

but as far as the purpose which they serve is concerned, namely, the assured propagation of the species, they approach in nature cleistogamic flowers; but they differ from them by the two kinds being produced on distinct plants.

With many plants, the flowers towards the outside of the inflorescence are much larger and more conspicuous than the central ones. As I shall not have occasion to refer to plants of this kind in the following chapters, I will here give a few details respecting them. It is familiar to every one that the ray-florets of the Compositæ often differ remarkably from the others; and so it is with the outer flowers of many Umbelliferae, some Cruciferae and a few other families. Several species of *Hydrangea* and *Viburnum* offer striking instances of the same fact. The Rubiaceous genus *Mussaenda* presents a very curious appearance from some of the flowers having the tip of one of the sepals developed into a large petal-like expansion, coloured either white or purple. The outer flowers in several Acanthaceae genera are large and conspicuous but sterile; the next in order are smaller, open, moderately fertile and capable of cross-fertilisation; whilst the central ones are cleistogamic, being still smaller, closed and highly fertile; so that here the inflorescence consists of three kinds of flowers. From what we know in other cases of the use of the corolla, coloured bractæ, &c., and from what H. Müller has observed on the frequency of the visits of insects to the flower-heads of the Umbelliferae and Compositæ being largely determined by their conspicuousness, there can be no doubt that the increased size of the corolla of the outer flowers, the inner ones being in all the above cases small, serves to attract insects. The result is that cross-fertilisation is thus favoured. Most flowers wither soon after being fertilised, but Hildebrand states that the ray-florets of the Compositæ last for a long time, until all those on the disc are impregnated; and this clearly shows the use of the former. The ray-florets, however, are of service in another and very different manner, namely, by folding inwards at night and during cold rainy weather, so as to protect the florets of the disc. Moreover they often contain matter which is excessively poisonous to insects, as may be seen in the use of flea-powder, and in the case of *Pyrethrum*, M. Belhomme has shown that the ray-florets are more poisonous than the disc-florets in the ratio of about three to two. We may therefore believe that the ray-florets are useful in protecting the flowers from being gnawed by insects.

It is a well-known yet remarkable fact that the circumferential flowers of many of the foregoing plants have both their male and female reproductive organs aborted, as with the *Hydrangea*, *Viburnum* and certain Compositæ; or the male organs alone are aborted, as in many Compositæ. Between the sexless, female and hermaphrodite states of these latter flowers, the finest gradations may be traced, as Hildebrand has shown. He also shows that there is a close relation between the size of the corolla in the ray-florets and the degree of abortion in their reproductive organs. As we have good reason to believe that these florets are highly serviceable to the plants which possess them, more especially by rendering the flower-heads conspicuous to insects, it is a natural inference that their corollas have been increased in size for this special purpose; and that their development has subsequently led, through the principle of compensation or balancement, to the more or less complete reduction of the reproductive organs. But an opposite view may be maintained, namely, that the reproductive organs first began to fail, as often happens under cultivation, and, as a consequence, the corolla became, through compensation, more highly developed. This view, however, is not probable, for when hermaphrodite plants

become dioecious or gyno-dioecious—that is, are converted into hermaphrodites and females—the corolla of the female seems to be almost invariably reduced in size in consequence of the abortion of the male organs. The difference in the result in these two classes of cases, may perhaps be accounted for by the matter saved through the abortion of the male organs in the females of gyno-dioecious and dioecious plants being directed (as we shall see in a future chapter) to the formation of an increased supply of seeds; whilst in the case of the exterior florets and flowers of the plants which we are here considering, such matter is expended in the development of a conspicuous corolla. Whether in the present class of cases the corolla was first affected, as seems to me the more probable view, or the reproductive organs first failed, their states of development are now firmly correlated. We see this well illustrated in *Hydrangea* and *Viburnum*; for when these plants are cultivated, the corollas of both the interior and exterior flowers become largely developed, and their reproductive organs are aborted.

There is a closely analogous subdivision of plants, including the genus *Muscari* (or Feather Hyacinth) and the allied *Bellevalia*, which bear both perfect flowers and closed bud-like bodies that never expand. The latter resemble in this respect cleistogamic flowers, but differ widely from them in being sterile and conspicuous. Not only the aborted flower-buds and their peduncles (which are elongated apparently through the principle of compensation) are brightly coloured, but so is the upper part of the spike—all, no doubt, for the sake of guiding insects to the inconspicuous perfect flowers. From such cases as these we may pass on to certain *Labiatae*, for instance, *Salvia Horminum*, in which (as I hear from Mr. Thiselton Dyer) the upper bracts are enlarged and brightly coloured, no doubt for the same purpose as before, with the flowers suppressed.

In the Carrot and other Umbelliferae, the central flower has its petals somewhat enlarged, and these are of a dark purplish-red tint; but it cannot be supposed that this one small flower makes the large white umbel at all more conspicuous to insects. The central flowers are said to be neuter or sterile, but I obtained by artificial fertilisation a seed (fruit) apparently perfect from one such flower. Occasionally two or three of the flowers next to the central one are similarly characterised; and according to Vaucher cette singulière dégénération s'étend quelquefois à l'ombelle entière." That the modified central flower is of no functional importance to the plant is almost certain. It may perhaps be a remnant of a former and ancient condition of the species, when one flower alone, the central one, was female and yielded seeds, as in the umbelliferous genus *Echinophora*. There is nothing surprising in the central flower tending to retain its former condition longer than the others; for when irregular flowers become regular or peloric, they are apt to be central; and such peloric flowers apparently owe their origin either to arrested development—that is, to the preservation of an early stage of development—or to reversion. Central and perfectly developed flowers in not a few plants in their normal condition (for instance, the common Rue and *Adoxa*) differ slightly in structure, as in the number of the parts, from the other flowers on the same plant. All such cases seem connected with the fact of the bud which stands at the end of the shoot being better nourished than the others, as it receives the most sap.

The cases hitherto mentioned relate to hermaphrodite species which bear differently constructed flowers; but there are some plants that produce differently formed seeds, of which Dr. Kuhn has given a list. With the Umbelliferae and Compositae, the flowers that produce these seeds likewise differ, and the differences in the structure of the seeds

are of a very important nature. The causes which have led to differences in the seeds on the same plant are not known; and it is very doubtful whether they subserve any special end.

We now come to our second Class, that of monœcious species, or those which have their sexes separated but borne on the same plant. The flowers necessarily differ, but when those of one sex include rudiments of the other sex, the difference between the two kinds is usually not great. When the difference is great, as we see in catkin-bearing plants, this depends largely on many of the species in this, as well as in the next or dioecious class, being fertilised by the aid of the wind; for the male flowers have in this case to produce a surprising amount of incoherent pollen. Some few monœcious plants consist of two bodies of individuals, with their flowers differing in function, though not in structure; for certain individuals mature their pollen before the female flowers on the same plant are ready for fertilisation, and are called proterandrous; whilst conversely other individuals, called proterogynous, have their stigmas mature before their pollen is ready. The purpose of this curious functional difference obviously is to favour the cross-fertilisation of distinct plants. A case of this kind was first observed by Delpino in the Walnut (*Juglans regia*), and has since been observed with the common Nut (*Corylus avellana*). I may add that according to H. Müller the individuals of some few hermaphrodite plants differ in a like manner; some being proterandrous and others proterogynous. On cultivated trees of the Walnut and Mulberry, the male flowers have been observed to abort on certain individuals, which have thus been converted into females; but whether there are any species in a state of nature which co-exist as monœcious and female individuals, I do not know.

The third Class consists of dioecious species, and the remarks made under the last class with respect to the amount of difference between the male and female flowers are here applicable. It is at present an inexplicable fact that with some dioecious plants, of which the Restiaceae of Australia and the Cape of Good Hope offer the most striking instance, the differentiation of the sexes has affected the whole plant to such an extent (as I hear from Mr. Thiselton Dyer) that that Mr. Bentham and Professor Oliver have often found it impossible to match the male and female specimens of the same species. In my seventh chapter some observations will be given on the gradual conversion of heterostyled and of ordinary hermaphrodite plants into dioecious or sub-dioecious species.

The fourth and last Class consists of the plants which were called polygamous by Linnæus; but it appears to me that it would be convenient to confine this term to the species which co-exist as hermaphrodites, males and females; and to give new names to several other combinations of the sexes—a plan which I shall here follow. Polygamous plants, in this confined sense of the term, may be divided into two sub-groups, according as the three sexual forms are found on the same individual or on distinct individuals. Of this latter or tricoicous sub-group, the common Ash (*Fraxinus excelsior*) offers a good instance: thus, I examined during the spring and autumn fifteen trees growing in the same field; and of these, eight produced male flowers alone, and in the autumn not a single seed; four produced only female flowers, which set an abundance of seeds; three were hermaphrodites, which had a different aspect from the other trees whilst in flower, and two of them produced nearly as many seeds as the female trees, whilst the third produced none, so that it was in function a male. The separation of the sexes, however, is not complete in the Ash; for the female flowers include stamens, which drop off at an early period, and their anthers, which never open or dehisce, generally contain pulpy matter instead of

pollen. On some female trees, however, I found a few anthers containing pollen-grains apparently sound. On the male trees most of the flowers include pistils, but these likewise drop off at an early period; and the ovules, which ultimately abort, are very small compared with those in female flowers of the same age.

Of the other or monoicous sub-group of polygamous plants, or those which bear hermaphrodite, male and female flowers on the same individual, the common Maple (*Acer campestre*) offers a good instance; but Lecoq states that some trees are truly dioecious, and this shows how easily one state passes into another.

A considerable number of plants generally ranked as polygamous exist under only two forms, namely, as hermaphrodites and females; and these may be called gyno-dioecious, of which the common Thyme offers a good example. In my seventh chapter I give some observations on plants of this nature. Other species, for instance several kinds of *Atriplex*, bear on the same plant hermaphrodite and female flowers; and these might be called gyno-monoecious, if a name were desirable for them.

Again there are plants which produce hermaphrodite and male flowers on the same individual, for instance, some species of *Galium*, *Veratrum*, &c.; and these might be called andro-monoecious. If there exist plants, the individuals of which consist of hermaphrodites and males, these might be distinguished as andro-dioecious. But, after making inquiries from several botanists, I can hear of no such cases. Lecoq, however, states, but without entering into full details, that some plants of *Caltha palustris* produce only male flowers, and that these live mingled with the hermaphrodites. The rarity of such cases as this last one is remarkable, as the presence of hermaphrodite and male flowers on the same individual is not an unusual occurrence; it would appear as if nature did not think it worth while to devote a distinct individual to the production of pollen, excepting when this was indispensably necessary, as in the case of dioecious species.

Expressing his warm thanks to Dr. Hooker for supplying him with specimens and for other aid; and to Mr. Thiselton Dyer and Professor Oliver for giving him much information and other assistance; Professor Asa Gray, to whom Mr. Darwin dedicates this work, who has uniformly aided him in many ways; and to Fritz Müller of St. Catharina, in Brazil, Mr. Darwin closes his introduction.

The work, in various chapters, treats fully in the true Darwinian style of Heterostyled Dimorphic Plants: Primulaceae, Hybrid Primulas, Heterostyled Dimorphic Plants, Heterostyled Trimorphic Plants, Illegitimate Offspring of Heterostyled Plants, Concluding Remarks on Heterostyled Plants, Polygamous, Dioecious, and Gyno-dioecious Plants, and Cleistogamic Flowers.

Although we are tempted to cull from the pages of this work to an extent that would amount to a large draught on the whole, yet we must confine ourselves to the following extract "On Some Wild Hybrid Verbascums":—

In an early part of this chapter I remarked that few other instances could be given of a hybrid spontaneously arising in such large numbers, and over so wide an extent of country, as that of the common oxlip; but perhaps the number of well-ascertained cases of naturally produced hybrid willows is equally great. Numerous spontaneous hybrids between several species of *Cistus*, found near Narbonne, have been carefully described by M. Timbal-Lagrave, and many hybrids between an *Acer* and *Orchis* have been observed by Dr. Weddell. In the genus *Verbascum*, hybrids are supposed to have often originated in a state of nature; some of these undoubtedly are hybrids, and several hybrids have originated

in gardens; but most of these cases require, as Gartner remarks, verification. Hence the following case is worth recording, more especially as the two species in question, *V. thapsus* and *lychnitis*, are perfectly fertile when insects are excluded, showing that the stigma of each flower receives its own pollen. Moreover the flowers offer only pollen to insects, and have not been rendered attractive to them by secreting nectar.

I transplanted a young wild plant into my garden for experimental purposes, and when it flowered it plainly differed from the two species just mentioned and from a third which grows in this neighbourhood. I thought that it was a strange variety of *V. thapsus*. It attained the height (by measurement) of 8 feet! It was covered with a net, and ten flowers were fertilised with pollen from the same plant; later in the season, when uncovered, the flowers were freely visited by pollen-collecting bees; nevertheless, although many capsules were produced, not one contained a single seed. During the following year this same plant was left uncovered near plants of *V. thapsus* and *lychnitis*; but again it did not produce a single seed. Four flowers, however, which were repeatedly fertilised with pollen of *V. lychnitis*, whilst the plant was temporarily kept under a net, produced four capsules, which contained five, one, two, and two seeds; at the same time three flowers were fertilised with pollen of *V. thapsus*, and these produced two, two, and three seeds. To show how unproductive these seven capsules were, I may state that a fine capsule from a plant of *V. thapsus* growing close by contained above 700 seeds. These facts led me to search the moderately-sized field whence my plant had been removed, and I found in it many plants of *V. thapsus* and *lychnitis* as well as thirty-three plants intermediate in character between these two species. These thirty-three plants differed much from one another. In the branching of the stem they more closely resembled *V. lychnitis* than *V. thapsus*, but in height the latter species. In the shape of their leaves they often closely approached *V. lychnitis*, but some had leaves extremely woolly on the upper surface and decurrent like those of *V. thapsus*; yet the degree of woolliness and of decurrency did not always go together. In the petals being flat and remaining open, and in the manner in which the anthers of the longer stamens were attached to the filaments, these plants all took more after *V. lychnitis* than *V. thapsus*. In the yellow colour of the corolla they all resembled the latter species. On the whole, these plants appeared to take rather more after *V. lychnitis* than *V. thapsus*. On the supposition that they were hybrids, it is not an anomalous circumstance that they should all have produced yellow flowers; for Gartner crossed white and yellow-flowered varieties of *Verbascum*, and the offspring thus produced never bore flowers of an intermediate tint, but either pure white or pure yellow flowers, generally of the latter colour.

POSTPONEMENTS.—We are compelled to postpone several important articles. Amongst reviews: On Shilling Class Books of Science and Literature, published by P. Stuart, Laurie School Depot, Paternoster-row.

CONTINUOUS BRAKES.

In nearly all the more calamitous of the great railway accidents of the last few years, those which have been attended by the largest destruction of life and property, we have had to point out that, even if the first step in the catastrophe were admitted to have been unavoidable, all the worst consequences would have been prevented if the train had been fitted with an effective continuous brake. The ordinary history is that

some obstacle, either unseen by the driver or seen too late for the application of hand brakes, has suddenly arrested the speed of the locomotive. The carriages immediately behind it, still running at 40 or 50 miles an hour, have dashed with fatal effect upon the ponderous engine, and those in the rear of the train, in their turn, have "telescoped" into or overridden those in front of them. In such circumstances, the frail bodies of the carriages have been reduced to splinters of shivered wood and glass, and passengers who have escaped the immediate shock of the collision have often been severely or fatally injured by the fragments which bore witness to its violence. In order to produce such consequences, it matters nothing what is the nature of the obstacle by which the engine has been checked; and some of the worst accidents of this class have been produced simply by its leaving the rails and burying axle deep in the ballast. More than once, and notably in an instance which will be fresh in the recollection of our readers, a train running in the opposite direction has come into collision with the wreck, and has thus furnished the material of a second "accident," sometimes even more fatal than the first. When these events have happened, we have explained, over and over again, that all the chief elements of danger to life, as far as the passengers were concerned, were traceable to the free running of many or most of the carriages; and that if their speed could have been diminished simultaneously with that of the engine, no great harm would in most cases have been produced. The truth of this assertion is so self-evident that it has ceased to require demonstration, and its obvious corollary, that an effective continuous brake is a necessary condition of safe travelling, is also manifest to the most humble capacity. Under our existing system of railway management, however, these truths, if they have ceased to require demonstration, still require to be urgently and constantly reiterated; and we are glad to be able to enforce them, on this occasion, by the history of events which might have been prepared for the purpose of giving experimental proof of the soundness of the doctrine which we have so often and so long maintained.

Recently the Scotch up express on the Midland railway, which had left Carlisle at 1.15, was approaching Leeds at a rapid rate. It was a long and heavy train, drawn by two engines, and near Kirkstall Abbey the driving axle of the leading engine broke in two. One of the driving wheels became detached, and was projected forward with such force that it was either thrown or rolled about 150 yards, and it ultimately fell over upon the down line. As the train contained Pullman cars, it was necessarily fitted with the Westinghouse Automatic Air-brake, and this was applied at its full force by the driver as soon as he felt the shock of the fracture. The momentum of every part of the train was immediately checked, nothing left the rails, there were only trifling collisions between the carriages, and no passenger sustained any more grievous injury than a shaking from the sudden stoppage. The engine is said to have been completely wrecked, and the rails for a considerable distance twisted like corkscrews. Splinters of the engine were thrown many hundred yards; but except that the leading axle and the stepboards of the first carriage were broken, no injury was done to the train, which was brought to absolute rest in hundred yards, or fifty yards before it reached its driving-wheel. Nor was the effect of the brake confined to its action upon its own train. A down train was due at the spot, and was rapidly approaching. Persons ran forward to stop it, and were barely in time to do so. If they had been too late—and they would have been too late if the up train had been wrecked, or even if had been stopped with less promptitude—

the down train must have come into collision with the detached driving wheel, and would probably have been thrown off the line, with the results with which we have been rendered only too familiar in similar cases. It is impossible to conceive circumstances in which all the conditions necessary to a great catastrophe should be more completely fulfilled, and yet they were all rendered harmless by the brake. In consequence of the damage to the permanent way, the train was delayed for two hours or more, and the other traffic was temporarily suspended. The locomotive was greatly injured, but no one has sustained any bodily harm, unless indeed, it be the driver, who is said to have been much hurt (presumably by some fragment of the axle), but who, nevertheless, retained his presence of mind in the emergency. We trust that he may not be suffered to go unrewarded.

This narrow escape ought to have great weight in inducing the Board of Trade, or Parliament if necessary, to insist upon all passenger trains being fitted with an efficient brake. Not the least interesting part of the case is that the accident was produced by a cause which could not have been prevented by any degree of care or foresight. Some railway men profess to believe that the security of trains should not depend upon effective brakes, but upon an elaborate code of signals, coupled with careful general management. These things are not to be despised, but the broken axle of Friday teaches that there may be accidents against which neither signals nor management can provide. Possibly the axle contained some hidden flaw; possibly it was to all appearance sound and strong. Doubtless it had been fairly tested before it became part of a locomotive; and the engines selected for express service are always supposed to be the best of their kind. However good they may be, it is plain that they must be liable to concealed weakness, which may cause them to fail at any moment, and that the only proper precaution against failure is to provide the means of rendering it comparatively innocuous if it should occur. We have lately called attention to a pamphlet which states, on the high authority of Sir Henry Tyler, that during the last twelve years as many as 600 deaths have been caused by railway accidents of a kind which continuous brakes would either have averted or have rendered harmless; and these 600 deaths imply, of course, some four or five times that number of cases of injury. Up to a certain time, it was possible for railway directors to say that the power of continuous brakes to prevent accidents was only a matter of surmise, and might not be realised in practice; that engineers and other permanent officials were opposed to them, as permanent officials are generally opposed to every innovation; and to make other excuses of a similar character. For the future, now that a demonstration of the utility of a continuous brake has been given in such a convincing manner, the occurrence of death or injury from collision with any obstacle which could be seen a hundred yards ahead will involve moral responsibilities of the gravest character, and will call forth the most emphatic condemnation from public opinion. It must be remembered, moreover, that the Board of Trade and Parliament, if they should be compelled to intervene, or Boards of Directors as long as discretionary power in this matter is left to them, will not fulfil their duties merely by the adoption of something which is called a continuous brake, unless it be the most effective which science has produced. But, of all the conditions of efficiency the most important is rapidity of application, so that the momentum of a train may be greatly reduced within a second or two seconds of the time when danger is perceived. When this condition is secured, a collision which it is too late to avert may yet be rendered comparatively innocuous.

INDUSTRY AND ART IN LONDON.

(FROM A CORRESPONDENT.)

MUSICAL INSTRUMENTS.—Considering the fact that so many persons, male as well as female, now play the piano, or at any rate a musical instrument of some kind, we deem it right from time to time to notice those instruments in which improvements are said to have been either effected or patented. For example, there are the pianos of the largely-advertising firm of J. Brinsmead and Sons, Wigmore-street, who lay much stress upon their check repeater—that, amongst other advantages, it is simpler than Erard's;—it certainly has all the appearance of being simpler. The pianos are upright, and the advantages professed are that there is a perfect repetition of the blow as well as perfect check of the hammer when the blow is not required a second time—affording an elastic and certain touch combined with perfect repetition. When struck by the fingers a corresponding blow of the hammer is elicited sympathetically, so that the faintest pianissimo or the most powerful fortissimo can be produced with the greatest ease. Another improvement is the sostenente sounding board. They may therefore be said to have a sustaining quality of tone. In discussing the advantages of the check repeater action of these pianos with some of the piano and music dealers, they said that at any rate there was an advantage in the metal bridge. This firm has, we were informed by same authority, probably managed to stand the test of aspirants to fortune, and of course *rien ne succède comme le succès*. They export a great deal. Mr. Brinsmead has published recently (Cassell and Co.) an interesting little work, "The History of the Pianoforte," which we reviewed not long since.

PRACTICAL ENTOMOLOGY, &c.—Let us now change the scene to a naturalist's and bird stuffer's, Mr. J. Gardner, sen., 374, Oxford-street, naturalist, &c., to her Majesty the Queen. There you find small birds of the most gorgeous plumage lying in glass cases on the counter in dozens, some of them being the charming little birds peopling the woods of part of tropical Queensland and colder New Zealand; then on a perch a young cockatoo so life-like that an Australian would find himself moved at the direct reminiscence. Mr. Gardner has at present exhibiting in the south gallery of the Westminster Aquarium some large glass cases containing herons, bitterns, grebes, and ducks, &c. The glass cases are, some of them, six feet by four feet six inches. Our naturalist says he is particularly successful in stuffing British aquatic birds. Last and not least, but an excellent specimen, we see in the window the dreaded Colorado Beetle or American bug. This specimen was caught in a growing crop of potatoes at Port Chester, West Chester County, N. Y., United States. Some of the general newspapers, such as *Court Journal* and *Land and Water*, have recently described the said specimen. There are the upper side, under side flying, wing cases raised, and profile. It is almost worth a visit to Oxford-street to see such a capital specimen, the insect looks as if only just deceased.

MUSICAL PUBLICATIONS.—The quantity of fine, clear music which is now produced in London at very reduced prices to the trade and public compared to the old style is great. Recently a quantity of classical music has been published without illustrated covers, as instances of which we may cite waltz pieces published at Hopwood and Crew's, New Bond-street, particularly an elaborate one, in which the warbling is almost immediately given effect to in bold character, followed by uneven playing and some short warbles. "Florence," a gem; "Tarentelle," *allegro vivace*, op. 210; "Doux Souvenir," "Causerie Musicale," which winds up with a very pretty little andante flourish. Another of the pieces without picture "Chaste Simpli-

city," of undeniable merit, is issued by Messrs. Moutries and Co, of Baker-street. A new song, "Amour Toujours," of which, as is well known, M. Victor Hugo has written the words, and Degessler the music. This is as melodious a song as has been produced for a long time—a sort of improvement on Gounod—giving ripe expression to the half sad philosophy of Hugo. Rigodon, an old dance, at Wood's, Great Marlborough-street, is a little after the same school. It deserves a good place amongst new music, though the publisher may be perhaps younger than some others. Messrs. Duff and Stewart's Pianoforte Tutor by Rochard, as an easy and thorough means of learning the instrument is not to be surpassed, if equalled by Hamilton or any of the others. In a very short time the tunes are reached, which are often varied by exercises on the clefs. We should reckon amongst the wonders of modern science the illustration of the key board, &c., enabling in a couple of pages or so of instruction the veriest tyro to acquire much practical knowledge. We have briefly indicated the peculiar merit of this tutor. Under this head we will conclude with a favourable mention of a sacred song (a new one) "Redemption," published by J. Goddard, Argyll-place, Regent-street, and words by Miss Winch are rather sweet; also a "Serenade" by Gounod for piano, a new arrangement of an old lullaby song, not merely a transcription, but also a meditation or reverie of uncommon treatment, arranged by Lindsay Sloper. There is a fancy prelude with serenade. We note that the variations give a brilliancy to the familiar air.

COMPOSITION FOR COVERING BOILERS AND STEAM PIPING.

A process has been employed for some time with great success for preventing the loss of heat from steam pipes, domes of generators, cylinders of steam engines, &c. It consists in covering the same with a mixture of sawdust (no matter from what wood) and ordinary flour paste in a very liquid state. The sawdust being added to make a thick paste, and applied according to the following directions, will form a compact mass, the adherence of which is very great when applied on clean surfaces of wrought or cast iron; but on copper pipes it is more difficult to apply the first coat: in which case it is necessary to wash the copper pipe to be covered with a clay wash made with potter's clay until it forms a thin coating, after which the sawdust and paste will adhere firmly. It is very simple to apply; any ordinary mason with a small trowel is all that is necessary. Lay on five successive coats one fifth of an inch thick, each layer making, when finished, one inch thick. Let the pipes or other objects to be covered be kept warm by the aid of a little steam, and let one coat be perfectly dry before applying a second. Should the pipes be outside, exposed to the open air, give them three or four coats of coal tar to make them waterproof, but if inside a building it is not necessary. It is well to pass the sawdust through a riddle, to cleanse it from the coarse fragments of wood which are always to be found among sawdust. There is no contraction in drying the composition, therefore no leakage. Steam pipes so covered, the correspondent believes, lose less heat than when covered by any other patented process sold for that purpose. It is much less expensive, and much more efficient. The sawdust is to be found in most factories, scarcely of any value. With 1 cwt. flour (about 3.75 dols.

worth), he says he can cover as much surface as formerly with 200 dols. worth of the composition he was then using, which cost him at the rate of 75 cents or 1 dol. per cwt. Its lightness renders it still more valuable for such purposes. There is very little expansion or contraction in the pipes, being well protected; therefore no leaky joints.—*Textile Manufacturer*.

MASON'S IMPROVEMENTS IN WARMING RAILWAY CARRIAGES.

THE object of this invention is to regulate the temperature of railway carriages in winter to a more uniform degree of heat, and consequently give more comfort to the passengers by utilising the exhaust or waste steam from the locomotive engine; thus dispensing with the foot warmers in ordinary use, and saving the expense now incurred by railway companies in heating the water and the labour in filling the foot warmer with hot water.

Mr. Mason purposes accomplishing his object in the following manner:—With suitable connections to the blast pipe of the locomotive engine he conveys the exhaust or waste steam through the carriages in pipes arranged under the seats or otherwise a may be found most advantageous, the outlet of the pipes to be at the rear of the trains. The amount of steam passing through the pipes to give the requisite temperature is under control of the guard of the train, and the pipes in the various carriages are attached together by means of flexible tubes, in order to allow for the varying distance between when starting or stopping the engine.

THE COLORADO BEETLE KILLER.

Mr. F. A. Whitney, of Sandusky, Iowa, U.S., has, it appears, discovered an insect which preys upon the now dreaded Colorado Beetle. He says it has a proboscis somewhat resembling the house fly, but seems to be of a hard nature, like bone. This bug strikes the beetle with this proboscis and seems to suck the life out of it, when he is ready for another. It seems to be a new discovery. He had not time to watch it very much, but saw it kill two beetles in ten minutes. It seems to destroy the most from three p.m. until dark. We give an illustration, for the benefit of our readers, of this beetle killer.



SPINED SOLDIER-BUG.
a, enlarged beak; b, bug with right wings expanded.

SONNET TO JANETTA.

O, sweetest idol of my spirit's song,
Whose beauty, shining, sheds a lucid light,
Fair and effulgent as the queen of night!
Whose charms to nature's gentlest works
belong:
Woo'd as the Muse, the more her strains
prolong.
To whose fair form, now shadow'd in my
sight,
My soul would sing; and night and day
delight
To list to words which murmur from her
tongue.
Who, sweet as Cynthia, has brought the dawn
To my closed eyelids; while, in dreamy sleep,
The love that pants for passion newly born
Hath breathed to wake, and silent vigils
keep!
Which, without thee, were as an empty shrine,
Or harp that slumbers for the touch divine.
HENRY GEORGE HELLON.

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President, SIR ANTONIO BRADY.

The Session 1876-7 terminated June, 1877. The new Session does not commence till November next.

Subscriptions are payable to Mr. G. A. STRETTON, the Receiver, 4, St. Martin's-place, S.W., who is the proper official to give receipts.
F. W. CAMPIN, Sec.

N.B.—The movement for the REDUCTION OF PATENT STAMP DUTIES is still on foot; those who wish to support it should at once communicate with the Secretary.

The Paper on the Patent Laws, by Mr. T. Morgan, A.S.E., Member of Council of the Inventors' Institute, read at the British Association, unavoidably stands over.

Proceedings of the Institute.

THE Institute being now out of Session, we have nothing of interest to report. We expect to give a long list of new Members next month.

Monthly Notices.

"Preventive Medicine in Relation to Public Health" is the subject of a work by Dr. Alfred Carpenter, M.D., of Croydon, which is now in the press. The volume will comprise a series of papers on sanitation, air, sewage, water, hints upon the management of sewage farms, &c. It will be published, in the course of the present month, by Messrs. Simpkin, Marshall and Co.

The College of Physical Science in Newcastle has, it appears, a committee sitting to devise improvements. Good will doubtless result from this course.

A new planet, after the unusual interval of nearly six months, is again announced. No. 173 was discovered on the 2nd inst., at Marseilles, and the discovery, like those of its two immediate predecessors, is due to M. Borelly, who has not yet, however, we believe, given names to any of the three.

"Mineral Statistics for 1876" are now, it is reported, in the hands of the printers, so that we may hope, says the *Athenaeum*, shortly to receive another of those lucid summaries of the annual progress of the mining industry of the United Kingdom which do so much credit to the unwearied industry of Mr. Robert Hunt.

A shower of sand which fell at Rome on the 22nd of June is described by Padre Secchi in the *Osservatore Romano*. The cloud obscured the sun's rays. The phenomenon does not appear to be rare in Italy, and it is traceable to the rising into the air of the sand of the African deserts.

Davyum is the name proposed to be given to the new metal discovered by M. Sergius Kern, of St. Petersburg, found by him in platinum "ores." It appears to occupy a place midway between molybdenum and ruthenium. M. Kern is studying its physical and chemical properties, and proposes the name of Davyum, in honour of Sir Humphrey Davy. Platinum, though found in the metallic state in alluvial deposits, is rarely, if ever, pure, being generally alloyed with iron, palladium, osmium, iridium, and copper.

Trade Marks Conference.—Three meetings of gentlemen interested in the pen, needle, and iron trades were held on the 9th ult. at Birmingham, for the purpose of devising some mode of obviating the difficulties now experienced in the proper registration of trade marks, more especially as regards common property marks. Mr. T. Seymour Saliman (London), solicitor to the society, presided, and Mr. H. R. Lack, registrar of trade marks, was present. The chairman defined trade marks as being of three kinds—private marks, partially private and partially common, and those entirely common to a trade. In the cotton trade great difficulties had been experienced owing to the resemblance of marks, and a committee was appointed at Manchester to investigate the points in dispute, and compare the different marks in use. It was suggested that a similar step might be taken in other trades. Many applications for registration had been kept back because of the difficulty of deciding whether or not they were "common," and the registrar desired some information on the subject to guide him in his decisions. The Master of the Rolls had given a decision that when a mark was used by more than three persons it was to be deemed a common mark. A general conversation ensued, and Mr. Lack, in reply to various questions, said a person could not register a mark which had been in common use for many years, but he could register a private device in connection with it, though in that case the mark itself would not become private property. Manufacturers could register their names, though they were not bound to do so. The proceedings at the subsequent meetings of needle manufacturers and ironmasters were of a very similar character. With regard to the needle trade, it was resolved to hold an adjourned meeting at Redditch, in order that some arrangement should be made for giving the registrar the information he required. The attendance at the ironmasters' meeting was small, partly because the trade-mark difficulty is not so great in that trade as in others. The chairman said that by a trade-mark law they would be able to protect their manufactures against the conspiracy of unprincipled manufacturers in foreign countries.

For the future admission of engineer students in the Royal Navy, a competitive examination of candidates will be held on the 11th September, and following days. Each engineer student will in future have to pay a sum of £25 per annum for the first three years. He is also to enter into a bond in the sum of £500 to enter the Royal Navy as engineer student on the completion of his period of service.

THE BRITISH ASSOCIATION, 1877.

As in former years, so now we give the most prominent position to the proceedings of the British Association for the Advancement of Science, commencing by placing before our readers the address of Professor Allan Thomson, the President, which was in effect as follows:—"After the long interval of thirty-six years the British Association for the Advancement of Science holds its annual meeting, the 47th since its foundation, in this beautiful and interesting locality; and, strangely enough, on this occasion as on the former, it passes from Glasgow to Plymouth. We are delighted to be assembled here, and are even surprised that the Association has been able so long to resist the power of attraction by which it has been gravitating towards this place. While we are prepared to be charmed with the surpassing beauty of its scenery, and know the deep interest of its prehistoric vestiges, its historic memories, and its artistic associations, we have been frequently reminded of its scientific vigour by the records of its active scientific work; and we are now ready and anxious to witness all we can behold of its energy and success in the application of scientific discovery to the practical arts. Should we, as might be expected in a place hitherto so famous in its relations to our naval and military history, find most prominent those relating to the mechanism of war, we shall still hope that the effect of greater perfection in the engines of destruction may only be the source of rendering peace more permanent and secure. It is a source of regret to myself, and may be, I fear, a cause of detriment to this meeting, that the choice of a President should have fallen upon one whose constant occupation with very special branches of science has fitted him so inadequately for the distinguished position to which he has been called. I can only derive comfort from knowing that, wherever it may be necessary, there are many others present most able to supply what may be wanting on my part; and I must, therefore, at once bespeak their assistance and your indulgence. I have selected for the subject of the remarks which I am about to offer for your acceptance a biological topic—namely, the "Development of the Forms of Animal Life," with which, he observed, his own studies had been largely occupied, and which had important bearings on the questions now agitating the scientific world. Having noticed the enormous change produced in scientific thought by the doctrine of natural selection brought forward simultaneously by Wallace and Darwin in 1858, the Professor said: "If it were warrantable to attribute so great a change of opinion as that to which I have adverted as occurring in my own time to the influence of any single intellect, it must be admitted that it is justly due to the vast range and accuracy of his knowledge of scientific facts, the quick appreciation of their mutual inter-dependence, and, above all, the unexampled clearness and candour in the statement of Charles Darwin. But while we readily acknowledge the large share which Darwin has had in guiding scientific thought into the newer tracks of biological doctrine, we shall also be disposed to allow that the slow and difficult process of emancipation from the thralldom of dogmatic opinion in regard to a system of creation, and the adoption of large and independent views more consistent with observation, reason, philosophy, and religion, has only been possible under the effect of the general progress of scientific knowledge and the acquisition of sounder methods of applying its principles to the explanation of natural phenomena. I have already referred to Goethe, Oken, Lamarck, and Geoffroy St. Hilaire as among the most prominent of the earlier pioneers in the modern or reformed conceptions of biological laws. But were it desirable to mark the progress of opinion by quoting other authors and labourers whose contributions have naturally supplied the materials out of which the new fabric has been constructed, I should have to produce a long catalogue of distinguished names, among which would be found those of Lyell and Owen, as earliest shaping the doctrines and guiding opinion in this country; Johannes Müller and Von Baer, as taking the places of Haller and Cuvier on the Continent; and a host of other faithful workers in biology belonging to the earlier part of this century, such as those of G. Trediranus, J. F. Meckel, Carus, and many more. To Huxley more especially and Herbert Spencer the greatest influence on British thought in the same direction is to be ascribed." With regard to the origin of life the President adopted the view that "it had been experimentally demonstrated that no development of organisms, even of the most simple kind, has been satisfactorily observed to occur in circumstances which entirely excluded the possibility

of their being descended from germs, or equivalent formative particles, belonging to pre-existing bodies of a similar kind. The reflection forces itself upon us that we are just as ignorant of the mode of first origins of all the compounds of the inorganic elements as we are of that of living matter; and we may therefore be excused if we suspend all theory and conjecture until we shall be guided to more reliable hypotheses through the plain track of observation and experiment. But the practical applications of the increased knowledge of the origin of minute animal and vegetable organisms are very numerous. It is now proved beyond doubt that the origin of putrefaction and fermentation is dependent on the presence in the substances which are the seat of change in these processes, or in the surrounding air, of the germs of minute organisms of an animal or vegetable nature, and that the maintenance of the chemical changes in which these processes mainly consist is coincident with and casually (if not essentially) dependent upon the growth and multiplication of these organisms. Professor Lister had the merit of being the first to apply the germ theory of putrefaction to explain the formation of putrid matters in the living body, and he has founded on this theory the now well-known antiseptic treatment of wounds, the importance of which it would be difficult to over-estimate. The success or failure of plans for the preservation of meat and other articles of food without question depends on the possibility of the complete exclusion of the germs which are the cause of putrefaction and fermentation; and their management must therefore be founded on the most accurate knowledge of these organisms, and the circumstances influencing the persistence of their vitality and the vigour of their growth. The theory of Biogenesis has also lately been the guide in the investigation of the causes of various forms of disease, both in the lower animals and in man, with the result of showing that in many of them the infective substance consists, in all probability, of germs of minute animal or vegetable organisms. There is very great probability, indeed, that all the zymotic diseases (by which we understand the various forms of fevers) have a similar origin. As has been well remarked by Baxter in an able paper on "The Action of Disinfectants," the analogies of action of contagia are similar to those of septic organisms, not to processes simply of oxidation or deoxidation. These organisms, studied in suitable fluids, multiply indefinitely when introduced in all putrid infinitesimal proportions. Thus they are, as near as we can perceive, the very essence of contagia."

The remainder of the President's address was occupied with an examination of the fundamental principles of embryology, tracing the gradual development of plants and animals from the germ or ovum. It was shown that the mode of this development is the same, varied only by increasing complexity of structure and subdivision of parts, as we advance from lower to higher organisms. The results to which the examination of the subject led the Professor were thus summed up in the conclusion of the address: "The formative or organizing property resides in the living substance of every organised cell and in each of its component molecules, and is a necessary part of the physical and chemical constitution of the organising elements in the conditions of life; and it scarcely needs to be said that these conditions may be as varied as the countless numbers of the molecules which compose the smallest particles of their substance. But, setting aside all speculation of a merely pangenetic kind, it appears to me that no one could have engaged in the study of embryological development for any time without becoming convinced that the phenomena which have been ascertained as to the first origin and formation of textures and organs in any individual animal are of so uniform a character as to indicate forcibly a law of connection and continuity between them; nor will his study of the phenomena of development in different animals have gone so far before he is equally strongly convinced of the similarity of plan in the development of the larger groups, and, to some extent, of the whole. I consider it impossible, therefore, for anyone to be a faithful student of first embryology, in the present state of science, without at the first time becoming an evolutionist. There may still be many difficulties, some inconsistencies, and much to learn, and there may remain beyond much which we shall never know; but I cannot conceive any doctrine professing to bring the phenomena of embryonic development within a general law which is not, like the theory of Darwin, consistent with their

fundamental identity, their endless variability, their subjugation to varying external influences and conditions, and with the possibility of the transmission of the vital conditions and properties, with all their variations, from individual to individual, and, in the long lapse of ages, from race to race. I regard it, therefore, as no exaggerated representation of the present state of our knowledge to say that the development of the individual in the higher animals repeats in its more general character, and in many of its specific phenomena, the development of the race. If we admit the progressive nature of the changes of development, their similarity in different groups, and their common characters in all animals—nay, even in some respects in both plants and animals, we can scarcely refuse to recognise the possibility of continuous derivation in the history of their origin; and however far we may be, by reason of the imperfection of our knowledge, from realising the precise nature of the chain of connection by which the actual descent has taken place, still there can be little doubt remaining in the minds of any unprejudiced student of embryology that it is only by the employment of such an hypothesis as that of evolution that further investigation in these several departments will be promoted, so as to bring us to a fuller comprehension of the most general law which regulates the adaptation of structure to function in the universe."

The various Sections met on Thursday morning, August 16th, at 11 o'clock.

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE.—The Mathematical and Physical Science Section met at the Guildhall. Professor Foster, the President, in the course of his opening address, said:—It was usual for Presidents to review the progress made in the year, and to estimate the advantage that might be expected to flow from such progress. With regard, however, to Physics and Mathematics, this post could not be undertaken by any one man, owing to the variety, or rather the unlikeness, of the subjects with which the sciences dealt, as well as their number. He would suggest, however, that such reports were in themselves of the utmost scientific value, and there were few ways in which the Association could more effectually fulfil its function of promoting the advancement of science than by aiding in their preparation and publication. The practical difficulties of the scheme were neither few nor trifling. Without, however, attempting to commit the Association to any burdensome outlay, it seemed to him possible that a systematic series of reports might be established in connection with the Section which would prove of very high value. In the early volumes of the Transactions of the Association such reports were more frequently found than in late years. He thought this form of activity of the Association might with great advantage be revived and systematized. He would, suggest, therefore, that committees should be appointed to report periodically, say at intervals of six years, giving a systematic account of all the important work done on the subject, and within the period to which it related. So far as the Association generally was concerned, he saw no reason why it should be put to any expense beyond the provision for the use of the committees of all important scientific periodicals re-

lating to Physics, and the printing of the reports prepared by such committees. The President then proceeded to discuss the mutual relations between Physics and Mathematics, in order to prove that not only had mathematical investigations aided Physics at every step, but had continually more and more entered into the very substance of Physics. In fact, the departure of all knowledge of Mathematics from men's minds would be the destruction of Physics.

Thanks having been given to the President for his address, the Section proceeded to the discussion of several papers of a highly technical and scientific character.

GEOLOGICAL SECTION.—This Section met in the Mechanics' Institute, Mr. W. Pengelly, F.R.S., President. The attendance was numerous. The President commenced the proceedings by delivering an interesting address on the "History of Cavern Exploration in Devonshire." The Oreston, Kent's Hole, Anstey's Cove, Yealm Bridge, the Ash Hole, and Brixham Beach caverns were described in their dimensions, beds, and organic remains. The following extract gives a fair idea of the character of the paper:—

"The two famous Torbay caverns have certain points of resemblance as well as some dissimilarity:—1. The lowest known bed in each is composed of materials which, while they differ in the two cases, agree in being such as may have been furnished by the districts adjacent to the cavern hills respectively, but not by the hills themselves, and must have been deposited prior to the existing local geographical conditions. Each bed contained flint implements and relics of bear, but neither of them those of hyæna. The fourth bed of Windmill-hill Cavern, Brixham, and the breccia of Kent's Hole, Torquay, are coeval and belonging to what I have called the Ursine period of the latter. 2. The beds just mentioned were in each cavern sealed with a sheet of stalagmite, which was partially broken up, and considerable portions of the subjacent beds were dislodged before the introduction of the beds next deposited. 3. The great bone bed both at Brixham and Torquay consisted of red clayey loam, with a large percentage of angular fragments of limestone, and contained implements of flint and chert, insculpting with remains of mammoth, the tichorhin rhinoceros, and hyæna. In fine, the cave earth of Kent's Hole and the third bed of Brixham Cavern corresponded in their materials, in their osseous contents, and in their flint tools. They both belong to what I have named the Hyænine period of the Torquay Cave. But there are points in which the two caverns differ:—1. While Kent's Hole was the home of man as well as of the contemporary hyæna during the absence of the human occupation, there is no reason to suppose that either man or any of the lower animals ever did more than make occasional visits to Brixham Cave. The latter contained no flint chips, no bone tools, no utilised pecten shells, no bits of charcoal, and no coprolites of hyæna, all of which occurred in the cave earth of Kent's Hole. 2. In the Torquay Cave relics of hyæna were much more abundant in the cave earth than those of any other species. Taking the teeth alone, of which vast numbers were found, those of the hyæna amounted to about 30 per cent. of the entire series, notwithstanding the fact that,

compared with most of the cave mammals, his jaws, when furnished completely, possess but few teeth. At Brixham, on the other hand, his relics of all kinds amounted to no more than 8.5 per cent. of all the osseous remains, while those of the bear rose to 53 per cent. 3. The entrances of Brixham Cavern were completely filled up and its history suspended not later than the end of the palæolithic era. Nothing occurred within it from the days when Devonshire was occupied by the cave and grizzly bears, reindeer, rhinoceros, cave lion, mammoth, and man, whose best tools were unpolished flints, until the quarryman broke into it early in A.D. 1858. Kent's Cavern, on the contrary, seems to have been closed and never visited by man from the earliest palæolithic times to our own, with the possible exception of the neolithic era, of which it cannot be said to have yielded any certain evidence. That the Kent's Hole men of the Hyænine period, to say nothing at present of their predecessors of the Breccia, belonged to the palæolithic era of Britain and Western Europe generally as defined by the archaeologist, and this is fully confirmed by their unpolished tools of flint and chert; and that they were prior to the deposition of even the oldest part of the peat bogs of Denmark, with the successive layers of beech, pedunculated oak, sessile oak, and Scotch fir we learn from the facts that even the lowest zone of the bogs has yielded no bones of mammals but those of recent species, and no tools but those of neolithic type; while even the granular stalagmite, the uppermost of the Hyænine beds in Kent's Hole, has afforded relics of Mammoth, rhinoceros tichorhinus, cave bear, and cave hyæna. That the men of the Cave Breccia or Ursine period were of still higher antiquity is obvious from the geological position of their industrial remains. That the two races of troglodytes were separated by a wide interval of time we learn from the sheet of crystalline stalagmite, sometimes 12ft. thick, laid down after the depositions of the breccia had ceased, and before the introduction of the cave earth had begun, as well as from the entire change of the materials composing the two deposits. But perhaps the fact which most emphatically indicates the chronological value of this interval is the difference in the faunas in the cave earth. As already stated, the remains of the hyæna greatly exceed in number those of any other mammal, and it may be added that he is also disclosed by almost every relic of his contemporaries, their jaws having through his agency lost their condyles and lower borders. Their bones are fractured after a fashion known by experience to be his, and the splinters into which they are broken are deeply scored with his teeth-marks. His presence is also attested by the abundance of his droppings in every branch of the cavern. In short, Kent's Hole was one of his homes. He dragged thither piecemeal such animals as he found dead near it, and the well-known habits of his representatives of our day have led us to expect all this from him. When, however, we turn to the breccia, a very different spectacle awaits us. We meet with no trace whatever of his presence; not a single relic of his skeleton, not a bone on which he has operated, not a coprolite to mark as much as a visit. Can it be doubted that had he then occupied

our country he would have taken up his abode in our caverns? Need we hesitate to regard this entire absence of all traces of so decided a cave-dweller as a proof that had he not yet made his advent in Britain? Are we not compelled to believe that man formed part of the Devonshire fauna long before the hyæna did? Is there any method of escaping the conclusion that between the era of the breccia and that of the cave-earth it was possible for the hyæna to reach Britain? I confess that in the present state of the evidence I see no escape, and that the conclusion thus forced on me compels me to believe also that the earliest men of Kent's Hole were interglacial, if not preglacial.

Mr. H. C. Sorby, President of the Microscopical Society, moved a vote of thanks to Mr. Pengelly for his interesting paper. He was glad to say that he had first moved a vote of money from the funds of the Association to be spent in the exploration of Kent's Hole, and they had reason to be proud of the results of Mr. Pengelly's investigation. (Cheers.)

Mr. Grieve seconded the motion, after some remarks by Professor Oldham, who had accompanied Mr. Pengelly in many of his explorations and researches.

The vote was carried by acclamation.

The President having acknowledged the compliment, proceeded to give a sketch of the geology of the coast from the Raine Head to the Bolt Tail, indicating the points of geological interest in the neighbourhood.

Mr. J. H. Collins read a paper on the drift of Plymouth Hoe.

Some conversation occurred with regard to raised beaches, in which Professor Harkness, Mr. Worth, and Mr. Pengelly took part.

Mr. R. N. Worth followed with notes on the palæontology of Plymouth.

Papers were also read on the Devonian system in England and in Belgium, on the succession of the paleozoic deposits of South Devon, on the carboniferous coast line of North Cornwall, on the junction of the limestone and culm measures near Chudleigh, on the Devonian rocks near Newton Abbot and Torquay, with remarks on the subject of the classification. A short conversation in which the President, Professor Harkness, and others engaged, brought the business of the day to a close.

BIOLOGY.—This section met under the presidency of Dr. Gwyn Jeffrey, who delivered a very elaborate address on "The Deep Sea Mollusca." The speech contained the results of investigations carried out by himself and others, many of which were tabulated. The closing remarks had reference to the modern doctrine of evolution. Upon this point Dr. Jeffrey observed that our knowledge was not sufficient to enable us to take for granted the transmutation of species. There was no proof of anything of the kind. Devolution or succession appeared to be the law of nature. Evolution, in its modern interpretation, might be regarded as the product of human imagination. He was not a believer in the fixity of species nor in their periodical extinction and replacement with other species. The notorious imperfection of the geological record was in itself sufficient to warn thinkers against the acceptance of such a theory. The learned President concluded by exhorting his hearers to confess their

ignorance on a matter which might require centuries of investigation to elucidate.

On the motion of Mr. Spencer Bate, seconded by Professor Rolleston, and supported by Professor Allen Thomson, a hearty vote of thanks was given to the learned President.

Professor Rolleston then read a report containing the result of an examination of certain British tumuli in Somersetshire.

The feature of interest in the Section was an address delivered by Professor Macalister on the subject of Embryology and Physiology, of which the following is an abstract:—During the 36 years which have elapsed since the former meeting of the British Association in Plymouth in the year 1841 the whole aspect of the sciences grouped under the name of biology had undergone a complete change. More especially was this true of the subjects which come under the consideration of the Department of Anatomy and Physiology. It is not enough to say that they have made enormous advances; they have become remodelled in almost every respect, and are now no mere adjuncts to a professional education, but have won for themselves a very prominent place among independent sciences. In two directions especially has our knowledge progressed of late years—viz., in pure physiology, where it is trenching on the domain of physical science, and in embryology. To the latter subject specially would I direct your attention. The records of embryological research during the past few years contain many important additions to our knowledge, especially in three directions—first as to the mechanism of fertilization, which has been elucidated by the observations of Hensen, Hertwig and E. Van Beneden; secondly, as to the history of the germinal vesicle traced by Butschli, and some of the previously-mentioned observers; and, thirdly, as to the formation of peculiar bodies extruded from the egg, which are called polar bodies, but whose true nature is as yet unknown. Among the observations on later stages of embryonic development two series are of very great interest—those on the primitive groove, and those on the first appearance of the vertebrate limbs. The primitive groove is a remarkable furrow which appears in the eggs of higher vertebrates for a short time and then vanishes, leaving no trace behind, and it has been identified as a trace of a change in position of the embryo in the germinal disc, which can be seen to take place in shark eggs, but which has preceded the earliest development and changes in higher forms. The recent observations of Rauber have shown its relation to the formation of the digestive canal, and those of Schafer correlate it to the early stages of the middle layer of the germ. The minute and careful study of the shark's egg made by Mr. Balfour demonstrates, first, that the earliest traces of limbs are thickening of the epiblast, and this is confirmed by Rolliker and others; secondly, that the limbs are the divided remains of a continuous lateral fin, and examination of the structure of the parts making up the limbs of vertebrates leads us to believe that each limb contains materials for more than one metamere, and it becomes an interesting subject for speculation as to why in vertebrate animals the number of limbs has never exceeded two pairs. This does not depend on any necessary morphological conditions, so there must be some mechani-

cal reason as yet unascertained, some peculiar adaptations of a four-limbed form for varieties of motion and volition, &c. which make the quadruped superior to the biped or milliped. In concluding our survey of recent progress in morphology, I would refer to the additions to our knowledge in my own Department—namely, Human Anatomy. Here the researches of Grüber and others have made descriptive anatomy much more definite than it was twenty years ago, and each year's progress is making the study of human anatomy not a mere matter of bones and names, as it has too often been heretofore, but a really scientific study, a practical application of scientific morphological principles.

On the motion of Dr. Jeffrey, seconded by Dr. Bennet, a vote of thanks was awarded to the lecturer.

ECONOMIC SCIENCE AND STATISTICS.—In this Section Lord Fortescue presided. The attendance was not large. The noble Earl opened the proceedings in a long address.

Lord Houghton, in moving a vote of thanks to the chairman, said he was glad the noble lord had touched upon living and interesting subjects rather than mere theory and speculation, because, if this branch of the Association was to continue to exist at all, it would derive its main advantage from its applying practical and distinct rules to the actual events of the day. The *raison d'être* of this section was to bring pure science into somewhat closer application with the social world in which we lived than was to be found in no other section of this Association, and the paper they had just heard was a sufficient proof of its usefulness. After some remarks on the various topics on the paper, he expressed regret the noble lord had not alluded to the Prisons Bill of last Session, which, with many good points, certainly had a tendency to diminish local self-government. The Act, however, was passed, and he hoped that every exertion would be made to retain whatever local autonomy was left.

Mr. Sampson Lloyd seconded the motion, which was passed by acclamation.

A very able paper by Mr. Stephen Bourne followed on the growth of population in relation to the means of subsistence. Its object was to show that there was a surplus productive power in England which depended on the growth of our population and that therefore there was reason for restraining that growth. Beyond that, means of employment must be found by opening new markets. The discussion was carried on by Mr. Walford, the author of "The Cyclopædia of Insurance;" Mr. Barclay, the founder of the Penny Banks; Dr. Farr, Mr. Collier, Dr. Hancock, Sir M. Lopes, M.P., Mr. McKnight (Edinburgh), &c.

Dr. Hancock read a paper, "On the Cost of adopting a complete System of Public Prosecution in England, as illustrated by the results of the Scotch and Irish systems of public prosecution." He showed that the extension to England of the system of public prosecution which had long existed in Scotland and Ireland was apparently only a question of time.

GEOGRAPHICAL SECTION.—The Geographical Section met in the Saltash-street Schools, under the presidency of Admiral Sir Erasmus Ommanney, with whom on the platform were Sir Samuel Baker, Sir James Alexander, Mr. R. N. Fowler, Bear-

Admiral Nolloth, Mr. Trelawny Saunders, and Mr. Henwood Thomas.

The President, in his introductory address, presented a general review of the magnitude of geographical research and the advance effected in geographical science during the 36 years which have elapsed since the Association last met in Plymouth. A large part of this review was devoted to a history of Polar exploration and the results of the various expeditions conducted under the directions of Captain James C. Ross, Sir John Franklin, Sir Edward Belcher, Captain Allen Young, and Captain Nares were described; and the services rendered by Swedes, Germans, Austrians, and Americans were also duly acknowledged. As an Arctic voyager Sir Erasmus Ommanney expressed his ungratified approval of the conduct of Sir George Nares, and his wise decision to return home at the time he did. He considered nothing could have been gained by the expedition remaining out another season. As to future exploration, he never was sanguine of the success generally expected by the advocates of the Smith Sound route. By the valuable information brought home by Nares as to the physical conditions of the paleocriatic ice, all idea of reaching the Pole from that direction or anywhere north of the Parry Group may be discarded. He thought this formidable ice, which, he believed, occupies all the circumpolar area within the 83rd parallel will arrest the voyager sooner or later in navigating towards the North Pole. But instead of nations racing for the Pole let them accomplish what was practicable; to complete the coast line of North Greenland would be interesting to all geographers, that is to connect the coast between Beaumont's farthest and Koldeway's north limit, of discovery at Cape Bismarck, and might be accomplished from a winter station on the east coast. A scientific survey of Franz Josef Land would be of great service to the interest of science. Payer observed a navigable sea from his extreme north position at Cape Fligeley, between him and Oscar Land. Research in that direction appeared to hold out a hope of success in finding more land in that direction. The Swedes were preparing an expedition to make a passage from Nova Zembla along the Siberian Coast to Behring's Straits. In the opinion of the President, however, all must admit that England retains the proud distinction of being the foremost nation in Polar research, and if Nares did not reach the Pole, his voyage has contributed largely to the sum of human knowledge. Among other subjects noticed by the President was the progress of ocean telegraphy, the courses and results of the *Challenger* expedition, investigations of maritime meteorologists, the exploration of Africa by Burton, Speke, Grant, Baker, Barth, Livingstone, Stanley, Gordon, and Cameron, the extensive surveys made in Asia, Madagascar, and New Guinea, the opening of the Suez Canal, the progress and development of America, the opening up of China and Japan, and the marvellous services which the growth of steam navigation has rendered to geographical science.

Sir Samuel Baker, in proposing a vote of thanks to Admiral Sir Erasmus Ommanney, adverted to the subject of African exploration. He remarked that in this work Englishmen had never failed in their part, except when the spirit was willing and the flesh was weak and the travellers died

on the way. England had peculiarly intimate relations with Africa, and thanks to its colonial possessions and the influence it possessed with the Seyyid of Zanzibar, who of all Oriental Potentates had shown the most honest desire to suppress the slave trade, it was better qualified than any other Power to undertake the work of exploration. To conduct a number of expeditions at one time and from different centres would involve enormous expense, and his advice was that in the future the Society and the public should support one English exploring agency rather than a series conducted by various nations at one and the same time.

Sir James Alexander seconded the motion, which was unanimously adopted.

Dr. Phil. M. Lindeman, of the Bremen Geographical Society, on behalf of Dr. O. Finch, director of the Zoological Museum at Bremen, read an interesting account of the German expedition to Western Siberia in 1876, and of the valuable natural history, climatological, geological, botanical, mineralogical, as well as geographical observations made by Dr. Finch and his travelling companion.

Mr. Trelawny Saunders expressed the great satisfaction he felt that the port of Bremen was now joining with Britain in attempting to extend the commerce of the temperate north-west to the Arctic north-east beyond the White Sea.

Mr. H. W. Bates, one of the assistant secretaries, on behalf of Mr. W. H. Tielkens, read the next paper, which contained a narrative of the expedition across Australia, led by Mr. Giles, with Mr. Tielkens second in command.

There was a brilliant *conversazione* in the Guildhall in the evening.

The various Sections resumed their sittings on Aug. 17th.

MATHEMATICAL AND PHYSICAL SCIENCE.—Sir William Thomson delivered an address and spoke on the possibility of life on a meteoric stone falling to the earth. A sentence which fell from the President in his inaugural address has stimulated curiosity on this subject.

Sir W. Thomson deprecated any attempt to give a scientific notion of the beginning of life on the earth, or on any other planet, large or small. If the wanderer be a meteoric stone of a few pounds that is going its way through space, it might be called a paradox to say that life had originated on a body of such small dignity; but if it were a fragment of some great inhabited world shot into space by one of the collisions which occasionally occur, it would almost certainly carry moss or insects, or seed or germs, with it. Once launched into space it would be in circumstances not incompatible with the continued life of seed or germs, and possibly even of some of the lower forms of plants or insects. Who can say that a Colorado beetle could not live on a meteoric voyage from Mars to the earth? Falling through 50 or 60 miles of the earth's atmosphere is an affair of a few seconds of time considering the actually observed velocities meteors relatively bear to the earth, which are from ten to 60 or 80 miles per second. Loose grass or moss, if there were any, would first be blown off and left to settle quietly down to the earth and take root and grow there. The more intense resistance of the air, according to Joule, melts and evaporates the outer crust of the stone, destroy-

ing every living thing on it. But lichens and insects in cracks or hollows half an inch from the surface are quite undisturbed, and when the stone reaches the earth they cannot but live and multiply if then and there they find suitable climate and food.

Mr. Glaisher said the falling meteoric stone would not become heated until it reached our atmosphere, and he saw no reason why life should not exist upon it. But as matter of fact he never knew organic matter of any kind having been found upon a meteoric stone.

Professor Houghton caused some laughter by saying that he could not, as an Irishman, see how the Colorado beetle referred to by Sir W. Thompson could become a father of a large and thriving family. He should not object to 50,000 papa beetles coming to this earth in the crevices of meteoric stones provided they left their wives at home.

Mr. Preece next gave an account of the telephone, of which there are two kinds, one for the transmission of the sounds of the human voice and the other for the transmission of varying musical tones. He traced the history of the instrument from its inception in 1832 by Mr. Page, an American physicist, down to the present time, now that it has been perfected by Professor Graham Bell, of Boston. The great peculiarity of the instrument, he said, was its ridiculous simplicity, and this he went on to show by means of numerous diagrams and models of the instrument. Mr. Preece said he had just returned from America, where he had conversed through wires 32 and 24 miles long. In Boston the telephone was used for business purposes, and he himself so used it in that city. He was anxious to have spoken on that occasion with Exeter, but he feared it would not be possible to do this satisfactorily because the wire would come in contact with other wires used for business purposes. It would be necessary to have the instruments connected by single wires before they could be extensively used.

Sir W. Thompson and Prof. Houghton caused much amusement by putting through the telephone a number of questions, the one with a broad Scotch accent and the other in a rich Irish brogue. The experiments appeared to be highly satisfactory.

Sir William Thomson thanked Mr. Preece most heartily for his paper. He would not take up the time of the Section by any remarks on the paper, but would merely read a few sentences from letters which that moment had been put into his hands, describing experiments which were made yesterday in his own laboratory at Glasgow with the help of his assistants, at the wish of Mr. Graham Bell. He understood that Mr. Graham Bell would be at Plymouth this evening, and he was sure that the Association would give him a very hearty welcome. (Cheers.) [We are astonished to find that Sir William is not reported to have made any allusion to the claims of Mr. Varley as an inventor of the telephone.—Ed. S. R.]

The following are the communications to which Sir William referred:—

"Mr. Graham Bell, the inventor of the Telephone, arrived in Glasgow yesterday morning. To-day we have been making experiments in the laboratory with the artificial cable. The instruments that he brought up were not adapted for speaking

through a cable, but we could speak through what would correspond to 100 miles of the Atlantic Cable. We are making some new resistance coils here, and are going to try this evening to speak through a longer length of cable. The telephone is the most wonderful invention I have ever seen. We could talk through 30,000 fathoms as easily as if we had been in the room together. He has improved this instrument very much since you saw it a year ago in America; he is going to the British Association in a day or two, but he wishes first to make some more experiments with the artificial cable. Mr. Bell and Mr. Hobson, Postmaster in Glasgow, were stationed with telephones, the former at the General Post Office and the latter at Hillhead Post-office, a distance of two miles, and immediately after 8 o'clock, when the pressure of business in the operating room was over for the day, they began a conversation which lasted without intermission until after 9 o'clock. Each of the two gentlemen heard the words spoken by the other with the greatest ease and distinctness. I had the pleasure myself of hearing with the most delightful plainness several sentences and songs which were spoken and sung at Hillhead, and there was no one in the room at either end who could not make out with ease the sense of what was spoken at the other end of the line."

The thanks of the Section to Mr. Preece were carried with acclamation.

BIOLOGY.—Only some score of visitors attended this section, which met in the Athenaeum, under the Presidency of Dr. J. Gwyn Jeffreys. The papers set down for consideration were five in number, they were of a very technical character, and two of them related to purely local topics. The interest they possessed was scientific in the strictest sense, and for the most part they abounded in minute details. Mr. Archer Briggs read one in which he gave an exhausting account of the different species of roses to be found in the neighbourhood of Plymouth. Mr. H. Trimmen read another on the *Lavatera Sylvestris*, recently found in the Scilly Islands. The other papers related to the movement of water in plants and the anticipatory inheritance in plants.

ANTHROPOLOGY.—In this department Mr. Francis Galton, the president, delivered the introductory address.

GEOGRAPHICAL SECTION.—Admiral Sir Erasmus Ommanney again presided in this Section.

Lieutenant Kitchener, R.E., read a report on the line of levels from the Mediterranean to the Sea of Galilee.

Captain Marsh described the journey overland to India which he made in 1872 via Mesher, Herat, Candahar, and the Bolan Pass.

Lord Houghton, in seconding the vote of thanks proposed by Sir James Alexander, remarked that the geographical information furnished by Captain Marsh was increased in importance by the political situation, which rendered every contribution as to the nature of the country and its people very acceptable.

Mr. A. Floyer followed with an interesting account of a journey he had made in Beloochistan in 1875-76.

Major-General Sir J. E. Alexander read the next paper, "On the Supposed True Site of Mount Sinai." In 1875 Sir J. Alexander made a journey to Egypt in connection with the project for the trans-

ference of Cleopatra's Needle to Great Britain, and he was then tempted to extend his journey to the Holy Land. Here he met Mr. Beavis, who had painted a picture of Jebel, or Rus Supsaphah, or "Willow Beast," which he considered the real Mount Sinai, in preference to the Jebel. This is favoured by Dean Stanley and other travellers. Supsaphah was surrounded by plains, which could have afforded suitable camping-ground for the Israelites, whereas the region around Musa was more mountainous.

The last paper on the list was one by Colonel Goodwin Austen, "On the source of the Brahmapootra or Sanpo."

ECONOMIC SCIENCE AND STATISTICS.—In this Section Mr. Hyde Clarke, F.C.S., read a paper "On the Debts and Liabilities of Sovereign or quasi-Sovereign states due to foreign creditors."

MECHANICAL SCIENCE.—This Section met in the School-rooms, Courtney-street; President, Mr. E. Woods, C.E. There was a good attendance. On the platform were Professor Sir W. Thomson, Mr. F. J. Bramwell, F.R.S., Mr. E. Easton, Captain Galton, Mr. Le Neve Foster, Mr. R. N. Fowler, &c.

The President delivered an interesting address on the Application of Adequate Brake Power to Control Railway Trains. He referred at some length to the appointment of the Royal Commission in 1874 to inquire into the causes contributory to accidents by railway collisions, the many experiments which were made by the Commissioners with a view to ascertain the friction of carriages and to discover the most available and effective mode of applying brake power, and the relative efficiency of the different brakes in use. Brakes are not sufficient. Continuous brakes appeared absolutely essential. In fact, brakes should be adapted to all the wheels of a train, and the guards should have the power to bring the whole of them into immediate action. Accordingly, the principal railway companies had reported to the Board of Trade that they had adopted the system of continuous brakes, and others were preparing to make trials of inventions which promised better results. It was no part of the duty of the Royal Commission to select for commendation any particular form of brake, but only to conduct trials with all possible care and record the facts which these trials disclosed. Mr. Woods illustrated the comparative efficiency of the different forms of brake power by diagrams. It appeared that the addition of sand increased the retarding power $1\frac{1}{2}$ per cent. The recommendations of the Commissioners had met with prompt attention by the railway companies. The question of the best form of brake blocks was also discussed. Cast iron and steel were fast superseding wooden blocks. The paper concluded with the following practical suggestions. The general adoption of the effective system of continuous brakes in carriages which had to run from one line to another would certainly be productive of much advantage, for in breaking up and re-making up a train at any junction station, they would be found fitted with the appliances requisite for working together. If the allied companies could agree to adopt the same system there is little doubt but that the conversion of ordinary into continuous brakes would proceed with far greater rapidity than

would be the case on the other assumption, and that the public would at a much earlier period be found to enjoy the full benefit of the change. Nevertheless, until sufficient time has been allowed for testing under all circumstances the merits of the different systems now on trial, it may be scarcely reasonable to expect the present adhesion of any considerable number of railway companies to one particular system. The time, however, had arrived not only when each system should be scrutinized and tested in the most complete manner, but when the companies should clearly set before themselves the conditions which a good continuous brake should satisfy. A study of the different systems of brakes came under the notice of the companies, and their behaviour under the different circumstances of this application seemed to point to the following as the conditions with a perfect continuous brake for heavy fast trains should be called upon to satisfy:—1, the brake power should be applied to all the wheels of the vehicles throughout the trains; 2, the power by which the blocks are forced up on the wheels should be adequate to skidding the wheels upon the speed becoming moderately reduced; 3, the driver should have the whole of the brake power of the train completely under his command, and be able to apply it at a moment's notice, as he is the first person likely to discover any obstruction ahead, and is primarily responsible for the regard of danger signals. He can thus stop the train at once, and no time is lost by his having to signal danger to the guard. 4, The guards should individually possess the like means of applying the continuous brake, that they may be enabled to stop the train without reference to the driver in an emergency which may have manifested itself to the guard, but of which the driver is unaware—such, for instance, as a broken axle or a carriage getting off the line; 5, the power in hand should be susceptible of easy modulation, that the driver may be able to apply a moderate amount only for effecting ordinary stops, while he keeps in reserve a proper excess of power to be used only in emergencies, as in the contingency of stopping rails; 6, full brake application should not require more than a very moderate effort on the part of driver or guard; 7, the pressure should be steady and distributed as equally as possible over all the wheels and acting upon them with the intervention of some elastic medium to prevent too sudden and violent action to occasion the snapping of chains and to inconvenience the passengers; 8, the machinery should be of simple construction, not likely soon to get out of order, and admitting of being easily repaired; 9, indication should be constantly afforded to driver and guard that the brakes are in proper condition to work or otherwise; 10, a power of working the tender brake and the van brakes by hand as well as by power may be advantageously retained; 11, the brakes to be self-acting in case of the severance of the train, and when severed the guards to have control over the several portions; 12, automatic action being provided, means should be furnished to the brake attendants for modifying that action instantaneously, according to the circumstances in which the train may be placed after an accident has occurred; 13, it would be dangerous, and, therefore, inadvisable, to give to passengers any power over the

brakes. Such seemed to be the principal conditions necessary for realising the conception of a perfect brake, and then, when carried into practice and combined with the power of applying at will a force which, inclusive of the friction of the train, should amount to 10 per cent. of its weight, would constitute an invaluable instrument in the hands of our trains' attendants for use under contingencies of almost daily occurrence at some place or another of the great net-work of railways which covers this country.

On the motion of Mr. C. W. Merrifield, F.R.S., seconded by Mr. W. H. Barlow, F.R.S., a vote of thanks was given to the President for his very lucid and interesting address, and at the request of the Section, it was ordered to be printed.

Sir William Thomson explained a navigation sounding machine of his invention for use at full speed. He also showed the mariner's compass with corrections for iron ships. In the course of his remarks on the sounding machine he explained how the 22lb. sinker attached to the end of the line was armed with tallow in the usual way, by which some of the bottom was brought up in the event of its being mud, shell, or sand, and by which it received an impression in the event of its being hard rock. When a sounding is taken without the bottom being reached the tallow was undisturbed. The 22lb. sinker is attached by a rope 9ft. long to an iron ring fastened to the end of a 330 fathom length of pianoforte steel wire, which is wound on a drum secured to the taffrail at the stern of the vessel by handles attached to the drum. Two men wind in the length of wire required to take a sounding, three in 100 fathoms in four minutes, although the vessel be going at 15 or 16 knots. In soundings as ordinarily taken, the amount of line taken to reach the bottom is generally the only means of ascertaining the depth, and when a vessel is under way even at a low rate of speed it is practically impossible to reach the bottom in anything over 50 fathoms of water. The process of reducing steam, stopping the vessel, taking the soundings, and getting up to full speed again, occupies at least half an hour, and causes not less than a quarter of an hour's actual detention, and in bad weather much more for any depth approaching 100 fathoms, and is always the occasion of anxious inquiry among the passengers, liable as they are to attribute every stopping of the ship to some terrible disaster. In this instrument it is not by the length of the wire paid out, but by the fluid pressure on a column of air in a glass tube that the depth is found. Sir William stated that experiments with this instrument had been conducted on board many ocean-going steamers, but notably on some of the White Star steamers, which it is generally admitted are the fastest now afloat. In the steamships *Britannia* and *Germania*, of this line, which have recently made the two quickest passages across the Atlantic, this instrument is in regular use, and some of the compressed air tubes were shown at the meeting of soundings taken during the last voyages both off the banks of Newfoundland, and on making land on the Irish coast at these times these vessels were going over 15 knots per hour, and had no difficulty in getting bottom in 100 fathoms in about one minute after letting go, while the time em-

ployed to haul in was about four or five minutes. Experiments had recently been made on board her Majesty's ship *Minotaur*, Captain Lord Walter Kerr, on her cruise from Portland to Vigo Bay, and he, too, has taken soundings in 90 fathoms of water without reducing speed, which were proved to be correctly indicated on the pressure tube, by reference to the Admiralty chart after ascertaining the position of the ship, by observations of the sun, or by cross bearings of the land. In concluding his remarks on the compass Sir William Thomson stated that he had just received a letter from Her Majesty's ship *Thunderer*, giving the result of observations made on her standard compass both prior and subsequent to the firing of her guns, last Monday, when His Royal Highness the Prince of Wales visited the vessel and went out in her for the purpose of watching her gun practice. These observations demonstrated the necessity for having continuously movable magnets, not only to overcome the change in magnetism, through lapse of time or change of latitude to which all iron vessels are liable, but also to correct the compass from time to time in accordance with such changes as frequently occur through the firing of the guns in iron vessels carrying heavy armaments.

The thanks of the section were given to Sir William Thomson for both inventions.

Mr. Margary read a paper on timber bridges.

The President asked if he had found the worm very destructive in the wooden piers or bridges, and what preparation affords the best protection against them?

Mr. Margary stated, as the result of many experiments on a large scale, that creosote resisted the worm better than any other preparation.

Professor O. Reynolds explained his dynamometis and compound turbines.

This concluded the business for the day.

In the evening an interesting lecture was delivered by Mr. Warrington Smyth in the Guildhall.

On Monday, 20th August, the Sections resumed their sittings, which had been suspended on Saturday, 18th, in favour of the excursion to Eddystone Lighthouse, &c.

SECTION A.—MATHEMATICS AND PHYSICS.—Meteorological Department.—Professor Everett read the report of the committee on Underground Temperature.

Dr. Barham, of Truro, read a note on "Some relations of Sea and Land Temperature in the South-West of England." The purpose of the note was to furnish some materials for a correct estimate of the reciprocal influence of land and sea on the temperature of the air in the South-West of England, and inferentially on that of the more eastern districts.

Dr. Merrifield read a paper on "The Meteorology of Plymouth," the result of consecutive observations taken daily at eight a.m., during the twelve years, 1865 to 1876 inclusive.

Mr. A. Mallock read a paper "On the Measurement of the Height of Clouds," describing a method adopted by him in which photographs of the same cloud are taken from different points, and a calculation made from the difference of the angles. The Chairman was of opinion that if the method were used systematically at the public observatories much useful information might be obtained. In a paper on "The Molecular Changes which take place

in Iron and Steel while Cooling," Mr. Mallock pointed out that when cooling iron has reached a certain temperature a change happens in the metal, in which a great deal of heat is given off, but the specific heat afterwards becomes higher. In heating the iron rises in temperature, as it receives heat up to a certain point; then, without the temperature rising, it will continually absorb heat, until after a certain interval the temperature rose very rapidly. In cooling the reverse process took place. Professor Barrett expressed great appreciation of the value of Mr. Mallock's paper.

Dr. Gladstone read a paper on "Some points connected with the Chemical Constitution of the Solar System." Professor McLeod pointed out reasons for altering Mr. Gladstone's figures more in favour of his theory. Mr. Landon (Devonport) said that, agreeing with the nebular theory, he had long ago thought that the planets must contain substances of lesser density than the sun. The more distant planets should have a greater preponderance of the lighter elements than those near the sun. Was it possible to determine this by spectrum analysis? He doubted whether the comets and meteors ever were part of the nebulae out of which the sun was formed. He suggested that they were fragments of nebulae, which had for a long period been balanced between two suns, and were finally drawn towards one of them by its greater power of attraction. This might account for their eccentric orbits. Mr. S. P. Thompson pointed out that in the case of the earth carbon was always combined with oxygen. It was found that in the meteors which had fallen, that carbon had also been combined with oxygen, an essential to animal and vegetable life. How this bore on Sir W. Thomson's idea as to meteoric life was obvious. Captain Abney said that Mr. Lockyear in a recent lecture had drawn attention to the smaller specific gravity of Neptune, and the more distant planets as proofs of the nebular theory. Dr. Gladstone, in the course of his replying to Mr. Landon's question, said it might be possible to make out what was in the atmosphere of some of the distant planets, but, unfortunately, their spectra, peculiar as they were, were at present unintelligible whether or not meteorites and comets originally formed part of the same nebulae as the solar system; at any rate, they had come into the system, and if they came from outside it his case was strengthened.

Sir W. Thomson followed "On the effect of Transverse Stress on the Magnetic Susceptibility of Iron." The paper described the results of experiments made by Messrs. Andrew and Thomas Gray, by aid of a Government grant of £100. These proved that the effect of transverse stress was to diminish magnetisation while the strength of the magnetising current was below a certain critical value, and to increase it when the current was above that value.

Mr. C. Chambers read a paper on "Magnetic Induction, as Affecting Observations of the Intensity of the Horizontal Component of the Earth's Magnetic Force." His chief conclusion was that the correction hitherto made for induction was unnecessary; and Sir W. Thomson observed that his rigorous investigations had removed what was a very great stumbling-block in observations of the kind, as he had showed that the supposed necessity for the correction was altogether a mistake.

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SECTION B.—CHEMICAL SCIENCE.—This Section met under the presidency of Dr. Abel.

In opening the proceedings Dr. Abel referred to the death of Mr. Gassiot, and thought it was desirable that they should express their regret at the death of this well-known man of science, and one of the most valued members of the Association. Mr. Gassiot, after an illness of long standing, died on the first day of the meeting of the Association. As they all knew he was not only one of the oldest, but, for a very long period, one of the most active members of the British Association. But it was not only on that account that they, in the Chemical Section, would feel his loss acutely. He was, as they were all aware, sincerely and actively attached to science, and they all admired his contributions to electrical science; but still more his large-hearted and judicious liberality in the promotion of science, by in every way aiding fellow-workers in obtaining the construction, for example, of costly apparatus, and placing them at the disposal of those who might not possess the means of purchasing them (hear, hear). Mr. Gassiot was an original member of the Chemical Society, and one of the most intimate friends of Faraday, and on these accounts also he (Dr. Abel) felt sure the chemical section would desire to record their feeling of sorrow at his loss and their sympathy with his family in their bereavement.

The reading of papers was then proceeded with.

Mr. A. Vernon Harcourt, M.A., F.R.S., read the first paper "On the Application of a New Unit of Light to the Examination of Coal Gas."

Mr. Charles T. Kingzett, F.C.S., read a paper on the subject of "Albumen of Commerce." Albumen is largely employed for fixing certain colours on cotton goods. Egg albumen is well adapted, and would be without fault, were it not for its high price. In printing albumen serves a double purpose—it acts as a vehicle for the colour, and serves simultaneously as a varnish. Blood albumen occurs in commerce in various forms. The most inferior variety is packed in casks in the liquid state, and consists merely of blood, which has been defibrinated by whipping. The purer forms of blood albumen are prepared from the blood of slaughtered animals, which, after coagulation, is filtered. Five oxen, or twenty sheep, or thirty-four calves are said to yield the same quantity of dry albumen, namely, two pounds. In producing blood albumen for commerce the objects borne in mind are the attainment of a substance whose solution is free from colour, possesses perfect coagulation, and which is cheap. The superior price of egg albumen has repeatedly led to various attempts to prepare a blood albumen of a similar whiteness and quality. In these attempts animal charcoal, incipient coagulation, air rendered ozonic by means of electric induction, have severally been employed, but none were competent to produce an albumen at all comparable in value to egg albumen. Mr. Kingzett then proceeded to describe the process for which, in conjunction with Mr. Zingler, he has secured letters patent. It may be conducted upon blood itself, or defibrinated blood produced by whipping, or preferably upon the serum of blood. He was led, in the first place, to the discovery by experimenting with the solution of "Sanitas" which is now

being largely manufactured. Without defining the nature and function of an antiseptic or disinfectant, but taking an infectant to be that body which causes disease, and further accepting disease as often caused by the putrefaction of albuminous principle, Mr. Kingzett affirmed that in "Sanitas" we have a true antiseptic and disinfectant, for it absolutely prevents that putrefaction. The albumen solution prepared by their process is, in its general characters, analogous to ordinary forms of albumen. The coagulation which results on beating is, however, somewhat different; instead of being precipitated in flocks and flakes it entirely gelatinizes. Besides being used in printing, their albumen is employed in preparing photographic papers; as a varnish for sizing and enamelling articles of wood, glass, or metal; in pharmacy, and for other purposes. Dr. Abel said there was no doubt it had long been a desideratum to obtain such a quality of blood albumen, and it appeared to him that the process of Mr. Kingzett was a most simple and effectual one, and one of considerable importance arising from the varied and great uses of albumen in printing on cotton goods, &c.

Mr. C. T. Kingzett, F.C.S., also read a paper on "Some New Reactions in Organic Chemistry." The author pointed out that in his first paper on this subject he had demonstrated the existence of two classes of the reaction in question, namely, that in which certain organic bodies give with strong sulphuric acid alone a violet colour, and that in which the presence of sugar was required for the development of this colour test. In all instances of the first class of reaction examined by the author he had found that the bodies in question gave glucose as a decomposition product when boiled with dilute sulphuric acid, thus explaining why sulphuric acid alone gives with such bodies the violet colour already described. In the present paper the author described the methods by which he had obtained glucose from hederic acid, a constituent of ivy leaves, and from resin of scammony. Mr. Kingzett, in contradistinction to the statement of Marquart, has established the absence of an alkaloid in the roots of convolvulus scammonia, and gave a description of a volatile oil obtained below 100 degrees on distillation of scammony resin.

Dr. B. H. Paul and Mr. C. T. Kingzett read papers upon "A preliminary account of an Alkaloid obtained from Japanese Aconite." The author described the alkaloid obtained from this variety of aconite root as a definite crystallisable substance, differing from all the descriptions given hitherto of the alkaloids from aconite. They had found the uncrystallisable gummy substance, accompanying this as well as other varieties of crude aconitine, to be a saline compound of the crystalline base, and not, as had been assumed, an amorphous alkaloid. The acid contained in this salt was found to be analogous to aconitic acid, and while the occurrence of such a salt was shown to be a probable result of the method of preparing aconitine, it was suggested that much of the discrepancy hitherto prevailing in regard to the chemistry of aconitine might be due to the association of this salt with the crystalline alkaloid.

Dr. Wright also read a paper upon a similar subject, and a brief discussion followed.

Two papers—one upon the principles of "Uric Acid Genesis," and the other upon the "Constitution of Metallic Acid," were taken as read.

The section then adjourned.

FOREIGN SCIENCE.

THE forthcoming Paris exhibition has led to property in inventions being brought under discussion. *Cosmos* says that no doubt there is much to do for the protection of the rights of inventors of every kind. Simplicity of forms, reduction of the expenses which fall on the author of an important invention before he has even been able to be certain by a practical application of the foundation of his hopes. The committee of encouragement of national industry proposes to write to M. Thirion approving strongly of international congresses and conferences, at the exhibition which would examine questions relative to the wages and legislation of different nations in regard to industrial, literary, and artistic property, and notably what concerns *brevets d'invention*. It would see with much satisfaction a certain uniformity introduced into the said brevets, and industrial and literary property, in the legislation of the different countries with which France has frequent commercial relations.

The personal staff of the first European station of the International African Association has been appointed. M. Crespel is the chief of it; M. Cambia, and M. Maes, Doctor of Natural Sciences, will accompany it. It is proposed to establish a depot at Zanzibar, and an agency which will establish the first scientific and hospital station sufficiently forward in the interior, upon the banks of Lake Tanganyika.

The paper alluded to continues to advocate the progress of meteorology. It appeared to us that it was formerly stated that the nickel iron mine of St. Catherine, a meteorite, was exhausted; however, this paper gives an elaborate analysis producing 50 to 63 iron, nickel 7 to 7, 8 to 34.

M. Coret has invented a little apparatus of very simple management, denoting the heating of insufficiently greased organs. It is composed principally of a certain number of metallic holders with elastic bottoms, filled with an easily dilatable fluid, the whole enclosed in a little metal cylinder. This instrument can be fixed on the axis, which carries it in its rotation without modifying length. But if the arbor has just been warmed, the liquor which fills the metallic holders is dilated, and a little stem which is soldered upon the exterior one is repulsed, and comes in contact with a bell sounding in the workshop, and warning of danger.

A remarkably new idea is being carried into working in Paris just now, in the form of a new apparatus designed to make the numbers of the houses visible during the night; four hundred and fifty municipal establishments (schools, police posts, &c.), are, or going to be, provided with this new mode of lighting. The acquirers of the riverine sites of the Avenue de l'Opera, by their contracts, have been obliged to apply it to the houses which they shall construct. The annual expense of this luminous numbering, supposing the duration of the lighting equals that of the public lights calculated for a lighting of ten hours daily for three hundred and sixty-five days will be raised to 27 francs 38 cents. The price of placing the number attains 100 francs; the apparatus, which is of an extreme simplicity, requires only a piercing to pass the pipe, which supplies the burner and four little seals in the facades, which cannot cause any serious disfigurement. For many years we have desired this advance in civilisation, which was also sought for the town of Paris, 15 years ago by Leopold Ouvry.

THE INVENTORS' INSTITUTE,

ESTABLISHED 1st MAY, 1862.

FORTNIGHTLY MEETINGS, DURING SESSION,

HELD (NOVEMBER TO MAY INCLUSIVE) AT

4, ST. MARTIN'S PLACE, TRAFALGAR SQUARE, W.C.

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PAST PRESIDENT—LORD RICHARD GROSVENOR, M.P., &c., from February, 1868, till May, 1871.

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